Sample Return Systems for Extreme Environments

Completed Technology Project (2012 - 2013)

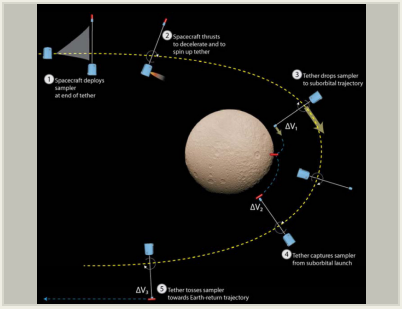
Project Introduction

Since the Apollo era, sample return missions have been primarily limited to asteroid sampling. More comprehensive sampling could yield critical information on the formation of the solar system and the potential of life beyond Earth. Hard landings at hypervelocity (1-2 km/s) would enable sampling to several feet below the surface penetration while minimizing the Delta V and mass requirements.

Combined with tether technology a host of potential targets becomes viable. The proposed work seeks to design, develop and test a hard impact penetrator/sampler that can withstand the hard impact and enable the sample to be returned to orbit. Tether technology for release of the penetrator and capture of the sample eliminate many of the restrictions that presently inhibit the development of sample return missions. The work builds upon in hypervelocity laboratory testing that use 1" Al projectiles that investigate crater formation and penetration through hard surfaces. The proposed work will enable realistic size (6" diameter) projectiles to be studied by taking advantage of the development of cheap high power commercial rocket motors that will enable impacts up to Mach 2 for Phase I. With this data, methodologies for studying higher velocity impacts can be developed along with mission scenarios to test the viability of mission return samples in the near future. Successful development of sample return capabilities will provide a major impetus for solar system exploration.

Anticipated Benefits

In Phase I we were able to demonstrate that sample return missions utilizing high velocity penetrators (0.1- 1 km/s) could provide substantial new capabilities for sample return missions at lower cost than soft landing techniques.



Project Image Sample Return Systems for Extreme Environments

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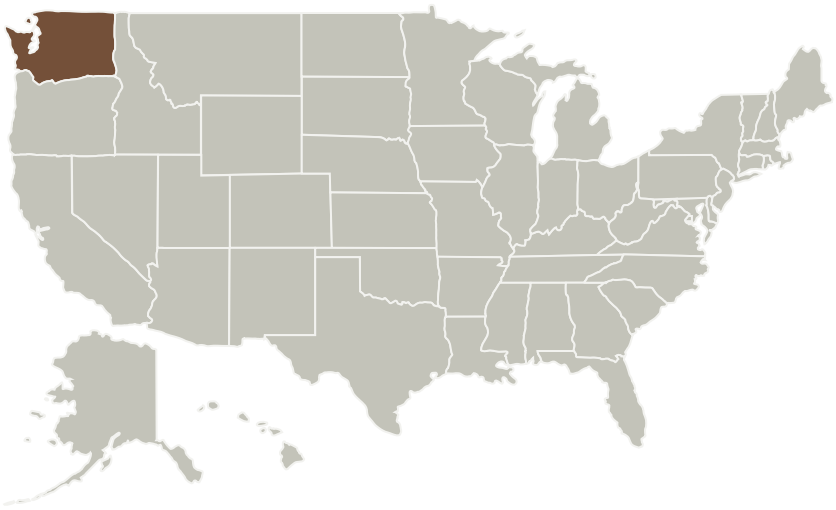
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Washington-Seattle Campus(UW)	Lead Organization	Academia	Seattle, Washington
Tethers Unlimited Inc	Supporting Organization	Industry	

Primary U.S. Work Locations
Washington

Project Transitions

September 2012: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Washington-Seattle Campus (UW)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

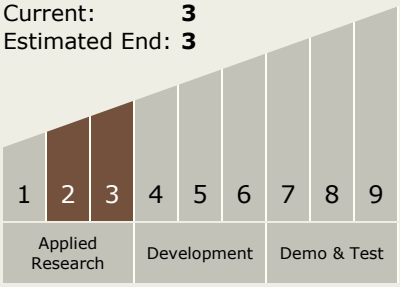
Eric A Eberly

Principal Investigator:

Robert M Winglee

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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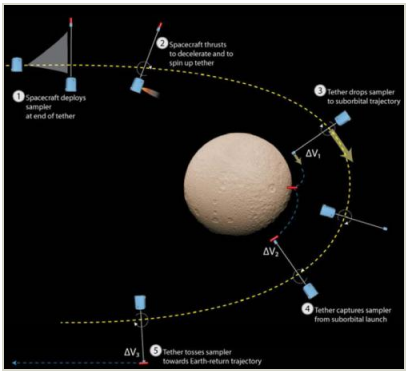
June 2013: Closed out

Closeout Summary: The analysis of the hard impact penetrator systems for sa mple return indicates that all components involved can meet the necessary requ irement to produce substantial new capabilities for sample return missions. The work includes the analysis of the overall mission requirements, the development of new energy absorbing material, tether analysis and penetrator design. This w ork culminated in the design and building of a prototype and its initial field testin g in a dry lake bed in Black Rock, Nevada. The modeling suggests that survivabil ity of sample return system for impacts up to speeds of about 1 km/s is possible and that the sample can be pulled from the surface with existing tether technolo gy. The field tests have demonstrated full survivability at 150 m/s and a means for field test evaluation at higher speeds has been demonstrated, along with the demonstration of sample collection through the feedports and into the main cha mber. The full system design indicates that major savings can be accomplished with multiple samples being taken in any single mission, leading to redundancy. This technology will be able for the first time to pull samples of the order of a fe w kg from depths of a few meters which could greatly enhance our knowledge of solar system objects and the resources therein. Moreover, it offers the opportuni ty to take multiple samples (from either multiple objects or from multiple areas of a few objects) at little extra cost so that it will provide much greater flexibility and greatly enhance the science return for any given mission.

Images



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Project Image Sample Return Systems for Extreme Environments
(https://techport.nasa.gov/image/102273)

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.3 Sample Handling

Target Destinations

The Moon, Mars, Others Inside the Solar System